



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>5</sup> : G02B 6/42, G01B 11/27 G03C 25/00	A1	(11) International Publication Number: WO 90/06529 (43) International Publication Date: 14 June 1990 (14.06.90)
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(21) International Application Number: PCT/GB89/01430

(22) International Filing Date: 29 November 1989 (29.11.89)

(30) Priority data:  
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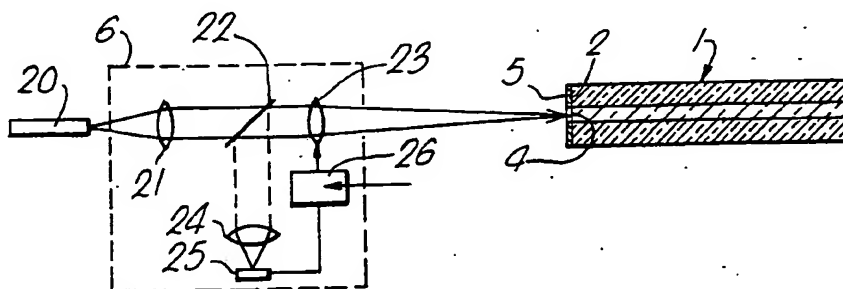
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(81) Designated States: AU, DK, JP, KR, US.

## Published

*With international search report.  
Before the expiration of the time limit for amending the  
claims and to be republished in the event of the receipt of  
amendments.*

(54) Title: AN OPTICAL DEVICE



## (57) Abstract

An optical fibre (1) has an endface (2) which has been coated with a metal oxide coating (5) such that the light guiding core region (4) of the endface (2) is at least partially bounded by the coating (5) whilst being uncoated itself. The core region (4) thus has a different reflectivity to that of the boundary region (3). The fibre may be used in a system for aligning a fibre with an optical device (20).

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AN OPTICAL DEVICE

This invention relates to an optical device having an optical waveguide.

It is often necessary to align a passive or active optical device with an optical waveguide, in order to obtain maximum efficiency in coupling optical signals between the waveguide and the device. When the waveguide is an optical fibre the light guiding region of the fibre, that is, the inner core region, must be aligned with the light emitting or light receiving region of the device.

In a known method of aligning an optical fibre with a laser, an optical signal from the laser is arranged to be incident on the fibre. The intensity of the signal emerging from the fibre is measured, and the position of the fibre relative to the laser is altered in order to obtain maximum intensity of the signal emerging from the fibre. The alignment is thus set initially by measurement. A disadvantage of this known method is that the alignment is set only initially and assumed to remain satisfactory thereafter. However, subsequent movement, vibration or temperature stresses may result in movement of the laser relative to the fibre. Any such movement therefore remains undetected, and maximum efficiency in coupling may no longer be achieved.

In a known method of detecting pits which form tracks in a compact disc, the pits are detected by a servo mechanism which detects the pits and adjusts a laser relative to the pits in order that the laser is locked onto the tracks. The servo mechanism acts to dynamically adjust the relative positions of

the laser and the pits in order to maintain maximum efficiency. The mechanism detects the pits in the compact disc, by detecting a difference in reflectivity between the pits and the remaining surface of the disc. Such servo laser devices are mass produced and therefore relatively cheap optical sources. However, they cannot be used to align the laser with known optical waveguides. It is an object of the present invention to solve this problem.

According to a first aspect of the present invention there is provided an optical apparatus comprising an optical waveguide having an endface; a light guiding region exposed at the endface and bounded at the endface by at least two opposing boundary regions, the reflectivity of the light guiding region being different to that of the boundary regions, characterised in that the apparatus further includes an optical source; alignment means responsive to the difference in reflectivity between the light guiding region and the boundary regions for aligning the optical source with the light guiding region.

An optical device can be arranged to scan the endface of the waveguide and thus detect and locate the position of the light guiding region. This thus enables the mass produced servoed laser devices to be used as optical sources for waveguide systems although, it is to be understood that some modification of the devices used in relation to compact discs may be necessary. For instance, the coupling arrangement between the laser and the waveguide may require modification.

According to a second aspect of the present invention there is provided a method of fabricating an optical waveguide having an endface; a light guiding region exposed at the endface and bounded at the endface by at least two opposing boundary regions exposed at the end-face, the reflectivity of the light guiding region at the end-face being different to that of the boundary regions, the method comprising coating at least a portion of the endface of the waveguide with a material which

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is of the type which breaks down when heated; passing an optical signal through the light guiding region thereby producing heat sufficient to cause the material to break down in the light guiding region of the endface but not in the boundary regions.

Conveniently, the waveguide is an optical fibre and the light guiding region is an inner core region, and the boundary region is an outer cladding region.

Alternatively, a planar waveguide such as lithium niobate with a titanium in-diffused channel may be used.

Preferably, the optical fibre comprises a coating of material covering substantially all of the cladding region and is fabricated by coating substantially all of the endface of the waveguide with the material which is of the type which breaks down when heated; passing an optical signal through the light guiding region thereby producing heat sufficient to cause the material to break down in the light guiding region.

Removal of the material in this way results in the automatic alignment of the surface reflecting boundary to the edge of the light guiding core region of the fibre at or near its boundary with the cladding.

The invention will now be described by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a known optical fibre;

Figure 2 is a perspective view of an optical fibre suitable for use with the present invention;

Figure 3 is a longitudinal cross section of the fibre of figure 2;

Figure 4 is a schematic representation of a servo mechanism and fibre forming an alignment system in accordance with the invention; and

Figure 5 is a perspective view of planar optical waveguide made suitable for use with the present invention.

Referring to Figure 1, a known optical fibre 1 comprises an endface 2 having an outer boundary region 3, and an inner light

guiding core region 4. Light travelling along the fibre is guided through the fibre within the light guiding region.

Referring to Figures 2 and 3, an optical fibre suitable for use with the invention is shown. The parts of the fibre which correspond to parts of the fibre of figure 1 are given equivalent reference numerals. The endface 2 of the fibre 1 has been coated with a coating 5 such that substantially all of the outer cladding region 3 is covered by the coating 5, and the inner core region 4 is substantially completely uncovered by the coating 5.

One method of forming the endface is to form a coating, for example, a metal oxide, and apply it to the endface 2 by evaporating or sputtering the metal oxide onto the endface. This results in substantially all of the endface being coated with the coating. An intense optical beam is then passed along the fibre 1. The intense optical beam is constrained by the fibre design to travel in the same spatial volume of the fibre in or near the core that a normal lower power signal would occupy. This causes the coating 5 over the core region 4 of the fibre to be removed by evaporation in the particular area which it is required to align with adjacent devices. The coating 5 remains covering substantially all of the cladding region, and has a reflectivity which is different from that of the core region 4. A metal oxide is chosen to form the coating as it will have an amorphous structure and will absorb the energy of the intense optical beam sufficiently to burn off. Other types of materials such as certain metals may also be used. The endface 2 of the fibre, when viewed axially, now comprises the core region 4 from which the coating 5 has been removed, surrounded by an annulus of coating 5. Because of the difference in reflectivity of the coating 5 and the core 4, an optical detecting device can be used to locate the core 4 by the difference in reflection from the core 4 and the annular coating 5 and so align the laser with the core.

Another method of forming the endface is to use selective deposition by masking.

Referring to Figure 4, an alignment system in accordance with the invention is shown schematically. The system comprises an optical fibre 1 of the type shown in figures 2 and 3 and an optical tracking source 6. The optical tracking source 6 is coupled to a laser 20 for producing an optical signal. The optical signal is focussed by lens 21 onto a beam splitter 22, such as a half reflecting mirror. The beam splitter 22 divides the optical signal into two beams such that a first portion is incident upon a second, moveable lens 23 which focusses the first portion onto the fibre endface. The beam splitter 22 directs a second portion of the optical signal onto a third lens 24 which focusses the second portion onto a matrix detector 25. A feed back and control system 26 links moveable lens 23 and matrix 25 to align the first portion of the optical beam with the waveguiding region of the fibre 1.

Referring to figure 5, a planar waveguide made in accordance with the invention is shown. The waveguide 7 comprises a lithium niobate block 8 having a titanium in-diffused channel 8 which is a light guiding region. The endface 9 of the waveguide 7 has been coated with a coating such that two opposite boundary regions 11, 12 of the lithium niobate block 8 are covered by the coating, and the light guiding region 8 is left uncovered.

In this context, the term "optical" is intended to refer to that part of the electromagnetic spectrum which is generally known as the visible region together with those parts of the infrared and ultraviolet regions at each end of the visible region which are capable of being transmitted by dielectric optical waveguides such as optical fibre.

CLAIMS

## 1. An optical apparatus comprising:

an optical waveguide having an endface; a light guiding region exposed at the endface and bounded at the endface by at least two opposing boundary regions, the reflectivity of the light guiding region being different to that of the boundary regions, characterised in that the apparatus further includes an optical source, and alignment means responsive to the difference in reflectivity between the light guiding region and the boundary regions for aligning the optical source with the light guiding region.

2. Apparatus according to claim 1 wherein the optical source is a laser.

3. Apparatus according to claim 1 or claim 2 in which the light guiding region of the optical waveguide is the inner core region and the boundary regions at least part of the outer cladding of an optical fibre.

4. Apparatus according to any one of the preceding claims in which the boundary regions of the optical waveguide have a coating at their endfaces.

5. Apparatus according to claim 4 wherein the coating is a metal oxide.

6. A method of fabricating an optical waveguide having a light guiding region bounded by at least two opposing boundary regions all exposed at an endface, the reflectivity of the light guiding region being different to that of the boundary regions at the endface the method comprising coating at least a portion of the endface of an optical waveguide with a material which is of the type which breaks down when heated; passing an optical signal through the light guiding region thereby producing heat sufficient to cause the material to break down



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in the light guiding region of the endface but not in the boundary regions.

7. A method according to claim 6 wherein endface is coated by evaporation.

8. A method according to claim 6 or 7 wherein the heat produced by the optical signal causes the material to evaporate.

9. A method of aligning an optical source to the light guiding region of an optical waveguide having a light guiding region bounded by at least two opposing boundary regions all exposed at an endface, the reflectivity of the light guiding region being different to that of the boundary regions at the endface the method comprising measuring the difference in reflectivity across the endface, thereby detecting the location of the light guiding region; moving the device relative to the waveguide in response to the reflectivity measurement, thereby aligning the device with the light guiding region.

1/1

Fig.1.

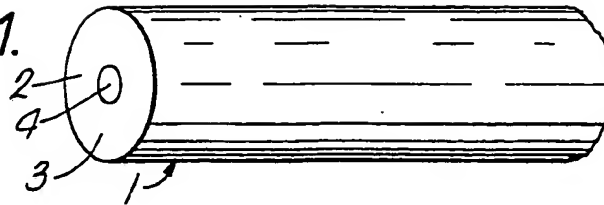


Fig.2.

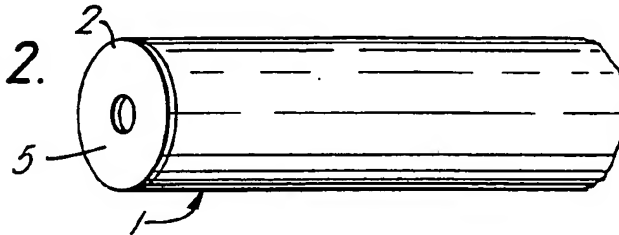


Fig.3.

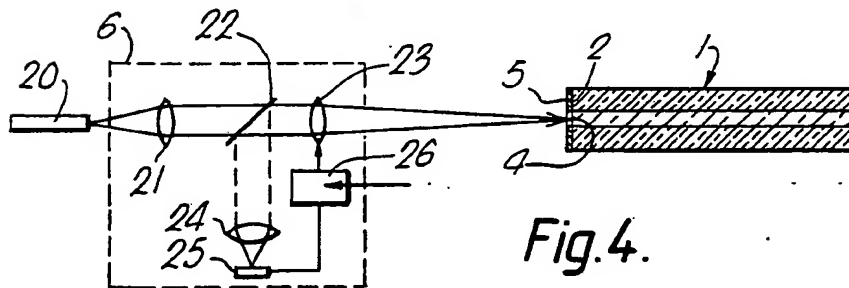
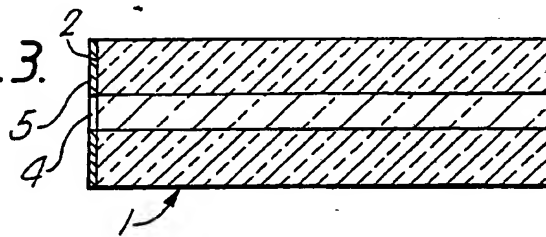
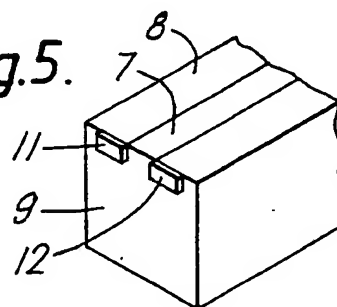


Fig.4.

Fig.5.



SUBSTITUTE SHEET

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 89/01430

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>5</sup> According to International Patent Classification (IPC) or to both National Classification and IPC IPC <sup>5</sup> :    G 02 B 6/42, G 01 B 11/27, G 03 C 25/00																							
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Minimum Documentation Searched <sup>7</sup></div> <div style="display: flex; justify-content: space-between;"> <div style="width: 30%; border-right: 1px solid black; padding: 5px;">           Classification System <sup>1</sup>             IPC<sup>5</sup> </div> <div style="width: 70%; padding: 5px;">           Classification Symbols             G 02 B 6/00, G 01 B 11/27, C 03 C 23/00,            C 03 C 25/00         </div> </div> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup></div>																							
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; text-align: left;">Category <sup>9</sup></th> <th style="width: 70%; text-align: left;">Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup></th> <th style="width: 20%; text-align: left;">Relevant to Claim No. <sup>13</sup></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td style="vertical-align: top;">           Patent Abstracts of Japan, volume 8, no. 92 (P-271)(1529), 27 April 1984, &amp; JP, A, 597312 (NIPPON DENKIN K.K.) 14 January 1984            see the abstract         </td> <td style="vertical-align: top;">1,9</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center; vertical-align: top;">--</td> <td style="vertical-align: top;">2,3,4</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td style="vertical-align: top;">           FR, A, 2535857 (SPECTEC) 11 May 1984.            see figures 2-5; page 1, lines 21-39; page 2, lines 1-19; revendications         </td> <td style="vertical-align: top;">1,9</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center; vertical-align: top;">--</td> <td style="vertical-align: top;">2</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="vertical-align: top;">           Electronics Letters, volume 11, no. 14, 10 July 1975,            R.B. Dyott: "Direct coupling from a GaAs laser into a single-mode fibre", pages 308-309            see the whole article         </td> <td style="vertical-align: top;">1,3,6</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="vertical-align: top;">           US, A, 4143940 (G.D. KHOE) 13 March 1979         </td> <td style="vertical-align: top;">1,3,5-7</td> </tr> </tbody> </table> <div style="text-align: right; margin-top: 5px;">./.</div>			Category <sup>9</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	Y	Patent Abstracts of Japan, volume 8, no. 92 (P-271)(1529), 27 April 1984, & JP, A, 597312 (NIPPON DENKIN K.K.) 14 January 1984 see the abstract	1,9	A	--	2,3,4	Y	FR, A, 2535857 (SPECTEC) 11 May 1984. see figures 2-5; page 1, lines 21-39; page 2, lines 1-19; revendications	1,9	A	--	2	A	Electronics Letters, volume 11, no. 14, 10 July 1975, R.B. Dyott: "Direct coupling from a GaAs laser into a single-mode fibre", pages 308-309 see the whole article	1,3,6	A	US, A, 4143940 (G.D. KHOE) 13 March 1979	1,3,5-7
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>10</sup> Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 50%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>																							
<b>IV. CERTIFICATION</b> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">           Date of the Actual Completion of the International Search  <b>7th March 1990</b> </td> <td style="width: 50%; padding: 5px;">           Date of Mailing of this International Search Report  <b>11 APR 1990</b> </td> </tr> <tr> <td style="width: 50%; padding: 5px;">           International Searching Authority  <b>EUROPEAN PATENT OFFICE</b> </td> <td style="width: 50%; padding: 5px;">           Signature of Authorized Officer:  <div style="text-align: right; margin-top: 10px;"> <b>T.K. WILLIS</b> </div> </td> </tr> </table>			Date of the Actual Completion of the International Search <b>7th March 1990</b>	Date of Mailing of this International Search Report <b>11 APR 1990</b>	International Searching Authority <b>EUROPEAN PATENT OFFICE</b>	Signature of Authorized Officer: <div style="text-align: right; margin-top: 10px;"> <b>T.K. WILLIS</b> </div>																	
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## III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
	see figure 1; column 2, lines 58-68; column 3, lines 1-22 --	
A	Patent Abstracts of Japan, volume 6, no. 53 (P-109)(931), 8 April 1982, & JP, A, 56167115 (FUJITSU K.K.) 22 December 1981 see the abstract --	1,3,4
A	Patent Abstracts of Japan, volume 4, no. 118 (P-24)(600), 22 August 1980, & JP, A, 5573011 (FUJITSU K.K.) 2 June 1980 see the abstract --	1,3,4,6
A	US, A, 4334774 (A.M. GLASS) 15 June 1982 see figure 6; column 3, lines 38-68; column 4, lines 1-3 --	1,9
A	US, A, 4367952 (H. AHRENS et al.) 11 January 1983 see figure 1; column 1, lines 6-50 -----	1,2,9

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
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GB 8901430  
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A- 2535857	11-05-84	None	
US-A- 4143940	13-03-79	NL-A- 7505451	11-11-76
		CA-A- 1062801	18-09-79
		DE-A, C 2619470	18-11-76
		FR-A, B 2337957	05-08-77
		GB-A- 1551359	30-08-79
		JP-A- 51137427	27-11-76
		SE-B- 410070	17-09-79
		SE-A- 7605171	10-11-76
US-A- 4334774	15-06-82	US-A- 4428644	31-01-84
US-A- 4367952	11-01-83	None	

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